Voyager Bulletin

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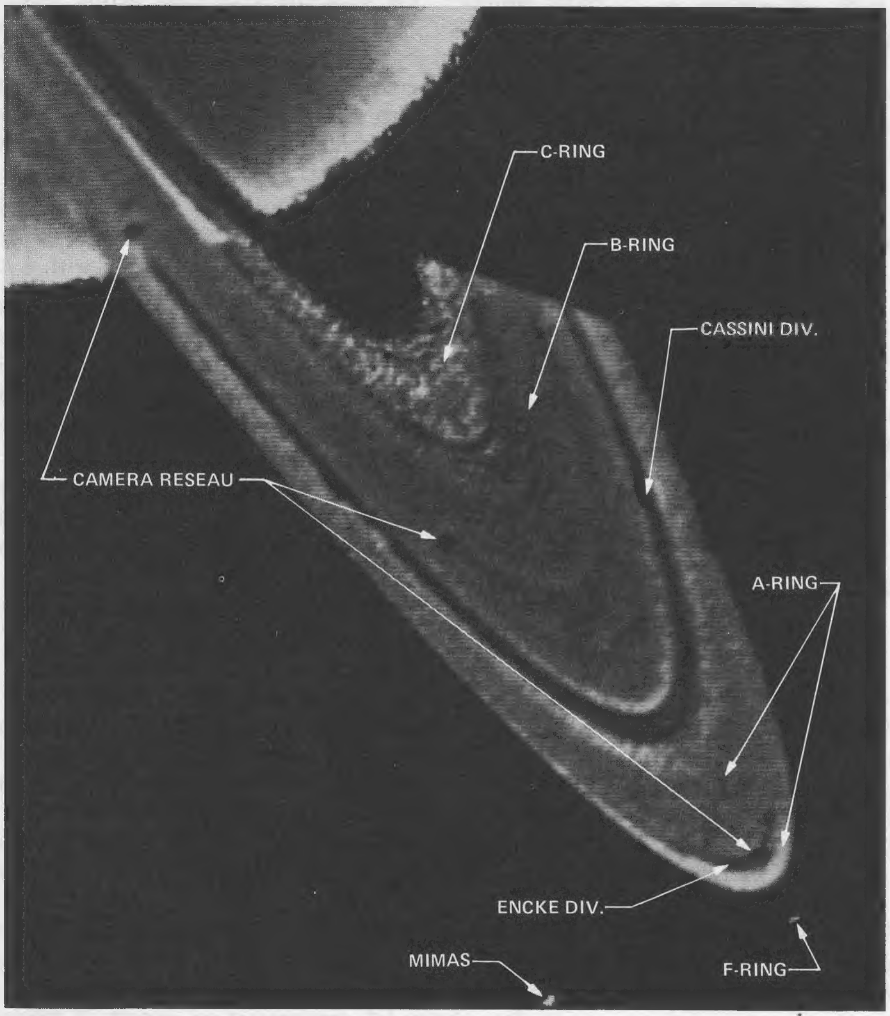

COMPUTER-ENHANCED — Subtle color variations and new structural features in Saturn's rings can be seen in this computer composite of four Voyager 1 photos taken on October 13, 1980, 40 million kilometers (25 million miles) from the planet. The Image Processing Lab at JPL combined and enhanced the photos to make this false-color picture which exaggerates some areas. The A-ring is split by the dark Encke Division. Between the A-ring and B-ring, the Cassini Division is filled with material discovered by Voyager 1. Considerable variations in distribution and brightness of material can be seen in the B-ring. Innermost ring visible here is the C-ring, which also shows variations in distribution and brightness of material. Variations can be seen in the planet itself. The abrupt cutoff of the rings to the right is the planet's shadow on the rings.

(Three black dots in image are reseau marks, artifacts of Voyager's camera system.)

Number of Satellites Growing

Two small satellites orbiting near the F-ring have been discovered in images taken October 25. Satellite 14 orbits about 800 kilometers (500 miles) inside the F-ring (but outside the A-ring), at about 79,500 kilometers (49,000 miles) above Saturn's cloudtops. Satellite 13 orbits about 2500 kilometers (1500 miles) outside the F-ring, at about 82,000 kilometers (51,000 miles) above the clouds. Based on their apparent brightnesses, the objects are about 250 to 300 kilometers (100 to 185 miles) in diameter.

Far Encounter Part Two Begins

On November 2, Voyager 1 begins the second half of its far encounter phase. This ten-day period includes a final adjustment to the flight path, a final operational readiness test for critical radio science during near encounter, and the highest resolution three-color 3x5 mosaic of Saturn and its rings. The far encounter phases will end November 11 as the near encounter computer sequences begin.

Voyager 1 is moving away from the sun with a velocity of 20.2 kilometers per second (45,000 miles an

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Voyager 1: Saturn Minus 12 Days
Voyager 2: Saturn Minus 298 Days

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hour). On November 2 it will be 14.1 million kilometers (8.8 million miles) from Saturn and 1.5 billion kilometers (949 million miles) from Earth. One-way light time – the time required for radio signals travelling at the speed of light to travel between earth and the spacecraft – is about 85 minutes.

On November 5, the radio science team and the Deep Space Network tracking stations will conduct a final operational readiness test in preparation for critical radio science experiments designed to study the atmospheres of Titan and Saturn, as well as the composition of the rings.

The last pre-encounter flight path adjustment is planned for November 6 to adjust the Titan aimpoint by about 500 kilometers.

Titan mosaics will begin early on November 11, 16 hours before closest approach to this satellite.

Celestial mechanics experiments, fields and particles measurements, and satellite searches will continue during this phase. Voyager 1 is expected to enter Saturn's magnetosphere sometime between November 9 - 12.

Press Activities

Voyager Project Manager Ray Heacock and Project Scientist Ed Stone of Caltech briefed NASA Administrator Dr. Robert Frosch and Presidential Science Advisor Frank Press in Washington, D.C., on October 27. The first Voyager Saturn press conference was held in Washington on October 28. Daily press conferences are planned in JPL's von Karman Auditorium November 6 through 15. Television broadcasts from JPL will be beamed around the world via SATCOM on November 11, 12, and 13.

SATURN's RINGS

Glimmering, glistening, beckoning, Saturn's rings are like the mythological Sirens – enticing, mysterious, confounding. Man has puzzled over their nature since Galileo first observed them in 1610. He first announced that Saturn was a triple planet having two small satellites rapidly and closely revolving around the bigger planet. Imagine his consternation when, in 1612, all traces of these small globes were gone!

Today we know that Galileo's globes are really a broad system of rings rotating around the planet's equator. Saturn's equatorial plane is tipped 27° to its orbital plane. The orbital motions of earth and Saturn result in a cycle in which earth is above the ring plane for about 15 years, and then below the plane for about 15 years. At the time of ring-plane passage, the rings appear edge-on to an earth-based observer, and hence, with simple viewing equipment like Galileo used, seem to disappear. Earth's upward ring plane crossing in March 1980 afforded astronomers the most recent opportunity to view the edge-on rings.

Voyager 1 will cross the ring plane twice – once inbound and once outbound. Now approaching from above the ring plane, Voyager 1 will dip below the ring plane about 18 hours before closest approach to the planet. Twenty-four hours later, the spacecraft will rise above the ring plane on an upward path which will send it 35° above the ecliptic (the plane in which most of our solar system orbits the sun) and 26° above Saturn's equatorial plane. On its outbound passage, Voyager 1 will fly through the E-ring, which is thought to be of rather low density and therefore harmless to the spacecraft. Just in case, however, Voyager 1's scan platform instruments will face in a direction such that no ring particles will pit optical surfaces.

The rings have been named in the order of their discovery; therefore, the labels do not indicate their relative positions. The A- and B-rings were discovered together. From the planet outward, they are designated the D (which may not exist), C, B, A, F, and E rings. Even now, however, it is obvious that the International Astronomical Union has its work cut out settling upon a nomenclature for the myriad concentric rings and other structure now being seen in Voyager photographs.

Divisions between the rings have been obvious since the 1600's, but Voyager's pictures are showing a much more complex ring structure than ever before observed. New divisions in the B- and C-rings are obvious, and more will most certainly be found before the end of Voyager 1's observations. Current theory supposes that gravitational effects from Saturn's satellites controlled the orbits of particles around the planet, but new mechanisms governing ring motions may be found.

The Cassini Division between the A and B rings, approximately 4000 kilometers (2500 miles) wide, is actually filled with material, and has divisions within itself.

Dark, radial features in the B-ring are puzzling since the ring particles rotate at different speeds. Theoretically, such features should never form, or at least be short-lived, since the outer potion of the rings rotates slower than the inner portion. But some of these features have observed lifetimes as long as three hours.

On October 25, the rings were photographed every 4.8 minutes for ten hours. When processed into a time-lapse movie, these pictures may show the radial features forming and dissipating. Density waves may also be visible.

What is the ring composition? Water ice in the rings was first identified in 1970; however, the variation in light reflected from the rings indicates that they are not pure water ice. Results from Pioneer 11 indicate that the ring reflectivity more resembles that of Jupiter's satellite Io – there is a reddening effect which could be due to trace impurities or to charged particle bombardment on an ice lattice.

How thick are the rings? The E-ring may be as thick as 1800 kilometers (1100 miles) – the driving distance from Los Angeles to Denver. Earth-based observations indicate that the visible rings may be just a few kilometers thick, if the particle sizes are less than 15 meters. Current theories favor multiple layers of ice or ice-covered rock with sizes about 1.5 centimeters or greater. A monolayer seems improbable partially because of previously-measured temperature differences between the lit and unlit sides of the rings. Voyager's infrared instrument will take the rings' temperature from both sides, several angles, and in the planet's shadow to help determine particle sizes. Radio experiments will also measure thicknesses, sizes, density, and composition of the rings.

How did the rings form? There are two major theories of ring formation: 1) through tidal breakup of a pre-existing comet or satellite, or 2) as a remnant of the proto-planetary nebula from which the planet itself formed. Findings on the particle size distribution and bulk composition should give an answer to this tantalizing question.

Pioneer 11 also found that Saturn's rings form an umbrella under which the radiation intensity drops dramatically. This region, in fact, was the most benign space through which Pioneer has travelled in its entire seven years of exploration. Saturn's radiation, therefore, is not expected to pose any threat to the Voyager spacecraft as they fly under the rings.